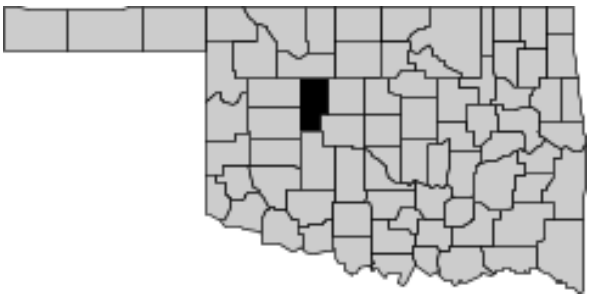
improved stimulation

K-Stewart Petroleum Corp.
Oklahoma City, Oklahoma

Morrow Formation
@ 8,300 ft



TECHNOLOGY AREA
Production Problems

PROBLEM
Formation Damage

SITUATION
Inconsistent Stimulation Results

RESULTS
Study Resulted in Recommendations For Improved Stimulation Procedures

Background

Many Morrow gas wells in the Carlton and Watonga fields of Blaine County, Oklahoma, do not respond consistently to acidizing and hydraulic fracturing. Although gas productivity typically improves with hydraulic fracturing, response to stimulation treatment tends to vary considerably from one well to another and any initial high production rates quickly drop off.

Project Description

K-Stewart contracted STIM-LAB to conduct a study to identify minimum formation damage completion and production techniques to maximize production following hydraulic fracturing. The project design was to compare the effects of various fluids on matrix permeability and fracture conductivity via laboratory tests, correlate production to completion and production practices through a relational database, and to relate laboratory testing to the field operations by correlating and characterizing the rocks tested in the database.

Results

The study resulted in recommendations that frac fluid and breaker be selected to minimize pressure drop, proppant be selected to provide maximum conductivity in the presence of multiphase flow, and maximize condensate yield to slow the steep decline in production. Maximizing condensate yield can be accomplished by holding a backpressure on the well during production to minimize pressure drawdown in the reservoir to avoid dropping out condensate in the surrounding formation, which would otherwise lower the effective conductivity.

Economics

No incremental production resulted from this project as it was a technology development project intended to produce results which could be utilize in future production activities. The project AFE was for $623,400 to drill a well to test the study recommendation (the well was not drilled) and an additional $50,000 for the stimulation study.

Project Funding

A project award of $673,400 (7.4% DOE, 92.6% K-Stewart) was made to K-Stewart for this project.

Project 13: **Improved Stimulation**, K-Stewart Petroleum	
Project Timing	Started: 9-16-96 Ended: 7-28-97 Duration: 11 months
Problem	Many Morrow formation gas wells do not respond consistently to acidizing and hydraulic fracturing treatments due to suspected formation damage. Fracture and acid stimulation results are generally not predictable, and it is difficult to predict whether a well will be a poor, average or good producer.
Proposed Solution &Technical Description	Analyze the historic completion and production characteristics of producing wells in the area to determine if there is a statistical difference in the performance of wells treated with different stimulation procedures. Characterize reservoir and fluid properties and correlate to treatment types and production responses and develop minimum formation damage technology. Conduct systematic analysis of geographic and lithologic variables in a regional database to identify correlating parameters with which to predict well response.
Reservoir Setting & Information	The gas productivity of Morrow reservoir wells in the Mocane-Laverne Gas area of northwest Oklahoma and the Oklahoma Panhandle is typically improved with hydraulic fracturing, but this increase is often short lived and the response to treatments is not consistent from one well to another.
Objective/intent	Program Objective: Develop new technology. Project Objective: Conduct study to identify minimum formation damage completion and production techniques to maximize gas production following hydraulic fracturing, then drill and complete a Morrow sand gas well utilizing the results of the study.
Working Hypothesis	Conduct the study, make recommendations, and drill the well compared with continued completion and operations with unpredictable results.
Baseline & Forecast	Average well pre-treatment production is 66 BOPD & 658 MCFD. A good producer's pre-treatment production is 299 BOPD & 3935 MCFD. Production after stimulation of average wells normally exceed pre-treatment rates 4 to 5 fold.
Compare: Actual vs baseline	Although the study was conducted and recommendations were made, low oil prices at the time of the project caused suspension of work-over and drilling activities.
Economic?	There is no data available with which to run economics. This project was intended to develop technical results, which could be utilized in stimulation treatments.
Project Objective Met?	The project objective was not met. The study was conducted as proposed, but there is no indication in the project documentation that the proposed well was ever drilled.
Program Objective Met?	The program objective was met. The study identified several factors that contributed to the inconsistency between treatments and to the nature of the production response characteristics. Several recommendations were made regarding treatment design and production practices, and the operators are in agreement with the recommendations made.
Application (area/region)	Study results have wide application to Morrow formation gas wells throughout the area.
Limitations	Limited to Morrow formation gas wells.
Recommendations	The project generated guidelines about the treatments to be used in this formation. These guidelines should be validated in application and, if profitable, moved to technology transfer.

resin-coated prepacked gravel pack

Industrial Technology Management (ITM) Torrance, California

Kern County California

TECHNOLOGY AREA
Production Problems

PROBLEM
Cost Efficient Sand Control

SITUATION
Conventional Sand Control Techniques are Expensive

RESULTS
Developed a Resin-Coated Prepacked Gravel Pack For Commercial Marketing

Background

Traditional prepacked gravel (sand) packs with external mesh wire wrapping are used for sand control in wells that produce sand along with oil. The wire mesh wrapping often becomes damaged during operations to set the traditional prepacked gravel pack. With the wire mesh damaged, sand control is less effective and leads to expensive remediation and/or failure to control sand production, causing more costly environmental remediation of oil-coated produced sand.

Project Description

ITM proposed to develop, construct, and test a resin-coated prepacked gravel pack that fits inside a perforated liner for sand control as an alternative to the traditional external wire-mesh wrapped prepakced gravel pack. The resin-coated prepacked gravel pack would be inserted into the wellbore for sand control.

Results

A prototype resin-coated prepacked gravel (sand) pack was manufactured and tested for permeability, bond strength, and chemical exposure. The tests indicate that the liner would be durable enough to with stand the typical down-hole environment and is resistant to most of the commonly found oil field chemicals. The gravel pack fits inside a perforated liner and has no wire wrapping or other mechanism for pack containment. The gravel pack consists of a commercial-grade resin-coated sand that has been shaped into a solid cylindrical form through the application of heat and formed in a cylindrical shape to conform to the internal dimensions of a wellbore. Liner joints are screwed together to the desired length, inserted into the wellbore, and set in place using conventional liner hanging equipment.

Economics

The product has not yet been field-tested in a well, although a field test candidate is being actively sought. The product is being introduced into the market in Bakersfield and Los Angeles, California. A resin-coated prepacked gravel (sand) pack is a less expensive product and the installation costs are about half the cost to install a conventional gravel pack system. The project has good application potential and offers considerable cost savings over conventional procedures, but does need a field demonstration to determine degree of technical success.

Project Funding

A project award of $99,500 (49.7% DOE, 50.3% ITM) was made to Industrial Technology Management for this technology development project.

Project 14: **Pre-Packed Resin Coated Liner**, Industrial Technology Management (ITM)	
Project Timing	Started: 6-17-97 Ended: 4-30-98 Duration: 11 months
Problem	Conventional sand control liners are expensive to install or replace, often resulting in wells being shut-in due to unfavorable remedial economics.
Proposed Solution & Technical Description	Develop an economical pre-packed resin coated gravel (sand) pack that fits inside a perforated liner which can be installed into the wellbore for sand control.
Reservoir Setting & Information	Conventional wire wrapped sand control liners (used for sand control in wells which tend to produce sand along with oil) are often damaged during installation or during use, resulting in a failure to control sand production, requiring expensive replacement.
Objective/intent	Program Objective: Develop new technology. Project Objective: Develop, construct, and field test an economical Pre-packed Resin Coated Liner prototype as a low cost sand control alternative to traditional wire wrapped sand control liners.
Working Hypothesis	Develop and utilize new technology compared to continued use of existing, often cost prohibitive completion and production methods.
Baseline & Forecast	Design a product for fast, economic, and versatile sand control completion, for well repair applications to restore sand control where economics require minimal repair cost.
Compare: Actual vs baseline	A prototype was designed and constructed, but due to low oil prices at the time of the project the product has not been tested in a producing well.
Economic?	This project was intended to develop technology to be utilized in production operations. The project final report indicates that the Prepacked Resin Coated Liner provides a cost effective alternative to existing gravel packing technology.
Project Objective Met?	The project objective was met. A prototype was constructed and tested as per the project proposal.
Program Objective Met?	The program objective was met. A product was developed which consists of a commercial-grade resin coated sand that has been shaped into a solid cylindrical shape (through heat application) to conform to the internal dimensions of a wellbore, and bonded to a perforated base pipe. The product has no wire wrapping or other mechanism for pack containment. Laboratory testing indicated that the product was suitable for downhole wellbore conditions.
Application (area/region)	The technology, if demonstrated successfully in actual oil producing wells, has world-wide application.
Limitations	No limitations unless determined by field testing under producing conditions.
Recommendations	Encourage field testing in an oil producing well, then if successful, incorporate into the Technology Transfer Program.